Circuit conventions

Dear Sir—I had hoped that it would not have been necessary for me to enter into prolonged correspondence on the subject of circuit conventions before publication of an article, but questions have been raised by W. A. Webster and M. G. Scroggie (Oct. 1970 *E & P*, pp. 383–384) which I feel obliged to acknowledge.

Let me first assure Mr. Scroggie that the 10-month interval between the appearance of Prof. M. G. Say's article (Oct. 1969 *E & P*, p. 355) and the publication of my letter (Aug. 1970 *E & P*, p. 293) was not due to inactivity or lack of interest on my part, although I was busy enough to be wary of a deep involvement. Rather, I felt duty bound to contribute immediately to the discussion, in view of a long association with the study of circuit conventions. My letter, which was drafted in October 1969, ran to over 3000 words, which made it unacceptable, and I made the mistake of changing it into an article, supposing, in my ignorance, that this would not cause any appreciable delay.

First, a matter on which both Mr. Webster and Mr. Scroggie agree is the rejection of signs which have been used to identify high- and low-potential terminals from the dawn of electrical engineering. I can make no comment other than to express surprise. Mr. Webster is hardly fair when he rejects a potential-difference (p.d.) convention, and quotes an example in which no p.d. exists. To enlarge somewhat on this matter, I feel great sympathy for him in his difficulties with students' questions, particularly in view of the fact that there is much muddled thinking on this topic.

I would respectfully suggest that in elementary teaching it is a good idea to produce careful explanations in simple terms which lead up to more advanced and useful concepts, and in this case it is as well to aim at the expression

$$-\int E.ds = \int \frac{\partial A}{\partial t} ds + \int \nabla V.ds$$

and to relate e.m.f.s and p.d.s to the terms on the right-hand side.

A good start to the concept of e.m.f. is to consider it as a nonelectrical agent tending to separate charges, which is a classical idea. Later gauge transformations and special relativity complicate the picture, but they do not invalidate the story, which starts in an elementary manner and builds up satisfactorily. Of course, this is not the only answer, but, if it is adopted, it makes Mr. Webster's explanations incorrect, and, in reply to Mr. Scroggie, it does not permit p.d.s and e.m.f.s to be distinguished by a glance at a phasor diagram. I have further discussed this matter at an elementary level in the article referred to above.*

Secondly, on matters of notation, Mr. Scroggie asks why I use capital letters for nodes. The answer is simply that, in my youth, the circuits which appeared most frequently had more branches than nodes; so I numbered the branches and lettered the nodes. Meshes did not come into it, but lower-case or Greek suffixes were used to identify current loops.

There is, of course, an error in the diagrams accompanying my first letter, and the symbols associated with Bow's notation should be E_{ab} and I_{ab}. I have not standardised the direction, because I make little personal use of the convention and would prefer to leave the choice to others.

Mr. Scroggie also takes me to task for suggesting that Bow's notation has any restrictions and for obscuring its origin. I was not aware of dealing with its origin, as I surmised that a lot of people, like myself, tentatively played with the idea and rejected it. The only point on which I wished to comment was that Mr. Scroggie seemed to be the only one to publish it and to expound many of its less obvious merits. I thought that I had given him due credit for this.

What are its restrictions? I could counter by asking about the restrictions of the classical arrows, but would rather not become involved in exchanging personal preferences. A master set of conventions, as distinct from a working notation designed to suit a specific problem, must meet the most exacting requirements. To fail one test is to fail! I will suggest two (and there are many others):

- How is a loop enclosing several elementary meshes to be represented without showing the path?
- How does one deal with a 3-dimensional circuit which is too complex to reproduce on flat paper? Some workers might prefer to attach arrows to the model in space. Are they to be prevented?

To conclude, I am recommending maximum freedom, and I believe that the method that I have proposed does go a long way towards securing it.—Yours faithfully,

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